International Journal of Knowledge and Language Processing
Volume **2**, Number 1, Dec **2011**

AKLP International ©2010 ISSN 2191-2734
pp. 19–39

Sentimental Direction Analysis: A Framework for Chinese Sentiment Computation and Resource Construction

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ABSTRACT. *People always use sentimental statement to express their opinions and attitudes. With the growing amount of opinion-rich resources such as online review sites and blogs, there's urgent need to extract the opinions of the mass for political and economic purposes. However, the automatic extraction has met a bottleneck that there is always more than one opinion/attitude in a text or in a sentence. Thus, the mainstream research is restricted to "one-attitude per sentence/text classification" as positive, negative, both or neutral, which causes many problems. Some researches try to figure out the holder and the object of the attitude without giving explicit definition of sentiment. This paper introduces a novel framework for multi-attitude sentiment computation by using a trigram <holder, attitude, object> called "Sentimental Direction" which is able to describe the special distinction in Chinese sentiment words. In Chinese, some words express the attitude of the "speaker" towards "agent/patient", some express the attitude of the "agent" to "patient", and some express both the 2 kinds. The framework can be applied for the detection of holders, objects and can deal with multi-attitude sentiments. After manually analyzing a lexicon of over 900 Chinese words, this paper specifies the sentimental direction's relationship with valence and the polarity of a word, and then put forward a bottom-up method for sentiment composition in sentences and documents. Finally, a semi-automatic method for the construction of sentiment lexicon is designed within the proposed framework.*

Keywords: sentiment analysis; sentimental direction; opinion extraction

1. **Introduction.**

One of the major functions of natural languages is to convey opinions and attitudes. With the growing amount of opinion-rich resources such as online review sites and blogs, the need to extract opinions of the mass is becoming rather urgent. For example, to summarize comments on phones, movies, tax laws and events from the web is very useful in recommendation and public opinion extraction systems. Accordingly, the late 1990s observed a sudden eruption of researches in the area of opinion mining and sentiment analysis. Today, the area is still very heated, with more and more researches conducted on the resources, models, algorithms and applications(see [1],[2]).

The aims of opinion mining and sentiment analysis are mainly about the automatic extraction of people's opinions/attitudes on an object in one document or opinion distribution on the web. What makes it difficult is the complexity of people's thoughts, as people usually express their attitudes towards different objects or different parts, attributes of the objects in a document. It becomes more difficult when people state or compare others' opinions in a document. Usually, the longer the document is, the more complex the opinions are, and the harder it is to extract the complicated opinions. So, the majority of researches, experiments and applications prefer the one-attitude one-object short documents for classification(see [3],[4],[5],[6]). In brief, how to extract the multi-attitude multi-object long documents has become the bottle neck of current research(see [7]).

To overcome the bottle neck, some basic resources like sentiment lexicons, tagged sentiment corpus are needed. And before that, a better theory or description frame for multi-attitude multi-object sentiment representation is needed so that the resources can be built on a solid foundation.

An opinion/attitude is usually defined as a trigram like <holder, attitude, object>, which describes a holder's attitude towards a given object expressed by a sentence or document (see [2]). For a sentence or document containing more than one attitude, we can have a list of the trigrams. Thus it seems we have solved the big problem. However, if we tagged all the trigrams in a sentiment corpus, it is still not clear which linguistic unit carries the sentiment. In broad sense, the sentiment words(or called "polarity words"), as well as some grammatical constructions, can encode the sentiments. However, sentiment lexicons having been built carry only grammatical and polarity features for each word(see Table 5 in section 7.2). The grammatical information is mainly the part-of-speech of the word. The polarity is tagged as positive, negative and neutral, or valued from -1.0(extreme negative) to 1.0(extreme positive). But they do not supply the critical information as to which is the attitude holder and which is the object. So the features they describe need to be integrated with the opinion trigrams. In some application systems like [8], the frame structure of the word has been used to get the attitude holder according to Fillmore's theory(see [9]). But they still treat each word as "one-holder, one-attitude", which are not adequate for every sentiment word.

(1a) 英国 作家 著书 **诬蔑** 新加坡 司法 被 判 监禁。

(1b) British writer wrote to **slander** Singapore's Judiciary was sentenced jail.

We try to use the trigram <holder, attitude, object> to analyze some Chinese sentiment verbs in sentences. We call the trigrams "sentimental directions", as the attitude always belongs to a holder and points to an object. For the purpose of the integration of syntax and polarity, we use the semantic roles "agent", "patient" and "dative" to be the holder and object. Compared to syntactic unit "subject", "object", semantic role can avoid the subject-object transposition which often happens in Chinese. Take the verb "诬蔑(slander)" as an example. Traditionally, it is regarded as a negative word, and it can fill the trigram as <"British writer", negative, "Singapore's Judiciary"> in sentence(1ab). Meanwhile, the writer/speaker of the sentence takes the same position with the Singapore government because he uses the verb "诬蔑" to express his negative attitude towards the British writer. In sentence(1ab) there're also trigrams in the form of <writer/speaker, negative, "British writer">, <writer/speaker, positive, "Singapore's Judiciary">. These are the attitudes expressed in the sentence. Thus the verb "诬蔑" may encode attitudes such as <writer/speaker, negative, agent>, <writer/speaker, positive, patient > and <agent, negative, patient>.

If we admit it is natural that the writer's attitudes are the basic view of a sentence, then the trigram <agent, negative, patient> does not simply carry the attitude from the agent, but the thought of the writer that he/she believes the agent has the attitude towards the patient. To make it clearer for analysis, we call the "speaker" as outer holder of the attitude, and "agent" as inner holder.

Why can a word express so many different attitudes? Does every sentiment word act this way? Will this kind of analysis be useful in application systems? To answer these questions, we manually annotated over 900 Chinese sentiment words. And we found there is an interesting distinction in Chinese sentiment words. Some words express the attitude of the speaker towards agent/patient, some express the attitude of the agent to patient, and some express both. The number of sentimental directions of a word is somewhat determined by the number of its semantic roles in sentences.

The remainder of this article is organized as follows. Section 2 introduces an integrated frame for multi-attitude sentiment representation. Section 3 gives a description of the corpus annotation scheme and inter-annotator agreement study for sentimental direction analysis. Section 4 shows the analysis of sentimental directions of verb, adjectives, adverbs, and nouns. In section 5, the analysis results are discussed from linguistic and computational perspectives. Section 6 gives the automatic construction of sentimental direction databases. Section 7 discusses related works, and a brief conclusion is given in section 8.

2. **Framework for Sentimental Direction Analysis.**

In this section, we define the terms for analysis with some examples in sentences.

2.1. Sentimental Direction.

Sentimental Direction(SD) is a trigram <holder, attitude, object>, in which the three elements represent the holder's positive or negative attitude towards an object. The holder

of the opinion or attitude is the writer/speaker of an expression or the agent of a sentiment predicate. For the holder “writer/speaker”, we will shorten it as “speaker” for the rest of this article. And the “speaker” is always a hidden sentiment role, unless the direct or indirect speech is used. The object of the opinion or attitude is the agent, patient or dative. The three semantic roles used in the paper differ a little from their normal linguistic use. The agent is typically the agentive role of a verb, which is also used for the experiencer of an adjective. The dative is the direct object of a bitransitive verb or the object of a proposition. The attitude from the holder to the object has 2 kinds of attitudes, positive(POS) and negative(NEG). The outer holder “speaker” carries the outer attitudes, while the inner holder “agent” carries the inner attitudes. Then the 2 holders may composite kinds of sentimental directions in sentiment words and phrases. Here, we define the terms as follows.

sentimental direction(trigram):=<holder, attitude, object>

holder:=outer holder | inner holder

holder:=speaker | agent

outer holder:=speaker

inner holder:=agent

object:=agent | patient | dative

attitude(polarity):=POS | NEG

word:{SD_i | SD_i:= <$holder_i$, $attitude_i$, $object_i$>, i>=0} (A word may have a number of sentimental directions)

phrase/sentence:{<WS($holder_i$), $attitude_i$, WS($object_i$)>, i>=0} (For phrases and sentences, whose attitude holders are words and phrases, need to map the semantic roles to word string by the function WS(semantic role)).

valence: The number of core semantic roles or arguments of the sentiment predicates is called “valence of the predicates”, and “val-1”, “val-2”, “val-3” can represent the valence number of intransitive verbs, transitive verbs and bitransitive verbs. The valence of the sentiment words is very important and will be discussed later.

2.2. Examples of Sentimental Direction Analysis.

As shown in (1a-b), the val-2 verb “污蔑(slander)” shows strong opinion of the speaker: <speaker, negative, agent>, <speaker, positive, patient> and <agent, negative, patient>. It can be clearly described using the sentimental direction framework as follows.

(1a’) Chinese:<speaker, NEG, “英国作家”>, <speaker, POS, “新加坡司法”>, <“英国作家”, NEG, “新加坡司法”>

(1b’) English:<speaker, NEG, “British writer”>, <speaker, POS, “Judiciary”>, <“British writer”, NEG, “Judiciary”>

There are 3 attitudes on 2 objects from 2 holders. It is obvious that the speaker does not agree with the British writer. From the sentence, it can be seen that the sentiment predicate verb “污蔑(slander)” aggregates 3 attitudes in a short sentence. If we replace it with “批评(criticize)” as shown in (2ab), the sentiments would be decreased from 3 to 1.

(2a) 英国 作家 著书 **批评** 新加坡 司法 被 判 监禁。
(2b) British writer wrote to **criticize** Singapore's Judiciary was sentenced jail.
(2a') Chinese: <"英国作家", NEG, "新加坡司法">
(2b') English: <"British writer", NEG, "Judiciary">

What makes the difference between the two verbs? Why "污蔑(slander)" is more complex than "批评(criticize)"? It can be easily seen that this is due to the different sentiment meanings of different words, which will be discussed with in later sections. What we want to emphasize at the moment is that the sentimental directions of words are different, and the novel method of attitude analysis by sentimental direction trigrams does possess some advantages in describing the differences. For the rest of the article, we will only give the English word strings in sentiment trigrams in sentences as (1b') and (2b').

3. **Annotation Methods.**

To make a relatively full overview of the sentimental directions of Chinese polarity words, we choose the words for investigation form the Chinese-English "Dictionary of Chinese Praise and Blame Words" (PBDict for short[10]) which is popular and helpful for the foreign Chinese learners. Every word is annotated with its sentiment trigrams by 3 Chinese postgraduates of linguistics. Linguistic principles are set to ensure the quality of annotation so as to obtain a sentiment lexicon of high agreement.

3.1. Source Data.

There are 1015 Chinese words in the PBDict, including verbs, nouns, adjectives, adverbs, idioms and phrases. As shown in figure 1, it gives a word's pinyin, part-of-speech, sentiment type, meaning, emotion, collocations, sentences, and English translation of the word, meaning, emotion, collocations and sentences. The sentiment types are tagged as positive, negative, and polite expressions. After trimming the polite expressions, there are 992 words left. For idioms and phrases, we manually tagged their part of speech. The resulting data contains 333 verbs, 498 adjectives, 20 adverbs and 141 nouns.

诬蔑 wu1mie4; smear, slander, vilify;
[动词]<贬>歪曲或捏造事实。常用于表示谎言或虚假的事实加害于人。含憎恶的感情色彩。
[Verb]<blame>Distort or fabricate facts. Commonly used to indicate using lies of fabrications to harm people. Connotation of loathing.
诬蔑好人 slander a good person; 受到诬蔑 suffer slander
我们要用铁的事实来揭穿他们诬蔑的用心。We shall use hard facts to expose their slanderous content.

FIGURE 1. **Information of "诬蔑" in PBDict**.

In addition, we use the general dictionary "Modern Chinese Dictionary[11]" to validate

the meanings and usages of words. We also use the “Semantic Knowledge-base of Contemporary Chinese(SKCC)”, which gives the valence(number of core semantic roles) of words[12]. To get more example sentences for investigation, we use the search engine Baidu and “Modern Chinese Balanced online Corpus” provided by Peking University.

Annotation Resources:

Meanings of word: PBDict, Modern Chinese Dictionary

Valence of words: Semantic Knowledge-base of Contemporary Chinese

Example Retrieval: Baidu(www.baidu.com), Modern Chinese Balanced online Corpus (http://ccl.pku.edu.cn:8080/ccl_corpus/index.jsp?dir=xiandai)

3.2. Annotation Principles.

There are often some mistakes in the annotation process, due to 3 factors: (1) typing errors, (2) tiredness, (3) obscure usage of word. The establishment of some basic principles for annotation may help to reduce the number of errors. The principles are given below.

(1) Consider only the sense with attitudes. If a word has more than 2 senses, we ignore the senses without attitudes. This is not hard to carry out, for the PBDict only gives the senses with attitudes. And there’re 55 words possessing 2 similar senses, which do not differ in sentimental directions. Only 2 words have opposite polarities. They are “骄傲(proud, adj.)” and “美化(beautify, vt.)”. Take “骄傲(proud)” for instance, it is positive when the agent is proud of his or other’s great achievement, and negative when the agent is proud of trivial things. We take the 2 words as 4 items, and the total count of the lexicon items come to 994.

For the words having senses with and without attitudes, it’s the task of word sense disambiguation in contexts.

(2) Consider simple sentences of sentimental words. For examples from search engine and corpus, we usually use the simple template “X verb Y”, like “X slander Y” and “X criticize Y” to determine the sentimental directions. It will highlight what we are concerned about and make the annotation more effective.

(3) Do not use polarity words on agent(X) or patient(Y) in the sentence. For it will lead to some errors. The phrase “诬蔑好人(slander a good person)” listed in PBDict is such an example. Sometimes, the phrase “good person” may mislead to tagging errors. We’d better eliminate “good”, and test the simple template “he slandered her” to see if the holder praised “her”.

(4) Do not add extra meanings to the words. It will be confusing if we add some extra meaning to agent, patient or dative. As in “他诬蔑她(he slandered her)”, we’d better not suppose that “他(he)” refers to a good person or a bad person beforehand, but just check what the sentiment is carried by the verb “诬蔑(slander)”.

(5) Do not take the meanings from the dictionary for granted. If there’s something wrong with the explanation from the dictionaries, word usage check should be performed from the online corpus and discussion with teammates should be needed.

(6) Use counter-attitude word to test the sentimental direction. When we write down the 3 elements in the trigram, we still need to test the element with counter-attitude word to see if it will make anomalous sentence, irony or other rhetorical phenomenon. As we know,

one of the sentiments of “诬蔑(slander)” is <speaker, NEG, agent>. When the sentence “好人诬蔑她(a good man slanders her)” is put under test, it is found to be a strange sentence. So the agent is indeed negated by the speaker.

The 3 postgraduates of linguistics annotated individually all the 992 words’ sentimental directions 3 times after 1-day training and discussion. In the first round of the annotation, the Kappa value of the 3 annotation results is about 0.7. For every disagreed word, there is a discussion on it to see what kind of factor has caused the disagreement. After 5 rounds, the tagging results come to complete agreement. Most of the disagreements were caused by factor (2) and (3). A few errors in the dictionaries are also corrected.

4. Sentimental Direction Analysis of Words from PBDict.

4.1. Verbs.

For all the Chinese polarity words observed, we found the verbs are the most interesting and most complicated.

4.1.1. Val-1 verbs.

Intransitive verbs like “凯旋(triumph)”, “得逞(managed to reach an evil goal with unscrupulous means)” have only one argument serving as agent subject in the sentence. This linguistic feature makes the sentimental direction simple and unique. As there is no other argument, the sentimental directions of these verbs, are the speaker’s attitude to the agent, namely <speaker, attitude, agent>.

凯旋:<speaker, POS, agent>
(3a) 战士们 **凯旋** 了。
(3b) The soldiers **triumphed**.
(3a’) <speaker, POS, “the soldiers”>

得逞:<speaker, NEG, agent>
(4a) 他 **得逞** 了。
(4b) He **prevailed** (by unscrupulous means).
(4a’) <speaker, NEG, “he”>

In (3a), “the soldiers” is the agent of verb “凯旋(triumph)”, and then it is the object praised by the speaker. In(4a), the verb “得逞(prevail)” has the agent of “he”. In other words, the author expressed his own opinion/attitude towards the agent by choosing different sentiment verbs. So the valence of verb relates to the type of sentimental direction, as the speaker has no choice but to put his attitude in the only argument of the val-1 verb.

4.1.2. Val-2 Verbs.

In section 4.1, the val-1 sentiment verbs express the speaker’s attitude to the only argument, the agent. What are the attitudes expressed by words with more than 2 arguments? We have shown the sentimental directions of 2 val-2 words “诬蔑(slander)” and “批评(criticize)”. Theoretically, the sentimental directions of val-2 verbs should be of 3 types: “speaker to agent”, “speaker to patient” or “agent to patient”. Indeed, after manual analysis

of the verbs, the 3 types are found in the lexicon which are able to produce more complex directions stated as follows.

4.1.2.1. Agent to Patient.

"Agent criticize patient" is the basic understanding of sentiment verb in traditional way, and there are 40 verbs which only have this kind of sentiment in the PBDict. The verbs "爱(love)"and "表扬(praise)"can be described as <agent, POS, patient>, and the verbs "讨厌(dislike)" and "伤害(hurt)" can be described as <agent, NEG, patient>.

4.1.2.2. Speaker to Agent.

Some verbs only have the "speaker to agent" attitude. For example, "挺进(advance)" and "把持(monopolize)" express the speaker's positive and negative attitude towards the agent respectively.

4.1.2.3. Speaker to Patient.

There's no verb with only the "speaker to patient" attitude. Attitude of this type always co-occurs with other attitudes, especially with "speaker to agent". As a result, a verb carries more than one attitude. Sometimes, the 2 attitudes are of the same polarity, such as "牺牲" and "散布", while sometimes not, like the verb "污蔑" discussed in section 2.2.

牺牲(sacrifice):<speaker, POS, agent>, <speaker, POS, patient>
(5a) 他 **牺牲** 自己 的 业余 时间 加班。
(5b) He **sacrificed** his spare time to work.
(5a') <speaker, POS, "he">, <speaker, POS, "his spare time">

散布(Spreading some information with malicious intent):<Speaker, NEG, agent>, <speaker, NEG, patient>
(6a) 他 **散布** 消息。
(6b) He **spread** information (with malicious intent).
(6a') <speaker, NEG, "he">, <speaker, NEG, "information">

4.1.2.4. Attitude Combination.

The three sentimental directions introduced above have 2 kinds of attitude holders, the speaker and the agent. The two holders coexist in many Chinese verbs as "诬蔑(slander)" discussed in section 2.2. The outer holder "speaker" and inner holder "agent" may composite kinds of sentimental directions shown as follows.

投身(throw oneself into a great enterprise)
Outer: <speaker, POS, agent>, <speaker, POS, patient>
Inner: <agent, POS, patient>
(7a) 他 **投身** 教育 事业。
(7b) He **devoted** himself to the cause of education.
(7a') Outer: <speaker, POS, he>, <speaker, POS, cause of education>
Inner: <"he", POS, "cause of education">

标榜(flaunt something bad with good names)
Outer: <speaker, NEG, agent>, <speaker, NEG, patient>
Inner: <agent, POS, patient>
(8a) 他 **标榜** 实用主义。
(8b) He **flaunts** pragmatism.
(8a')Outer: <speaker, NEG, he>, <speaker, NEG, pragmatism>
Inner: <"he", POS, "pragmatism">

4.1.2.5 Container Verbs.

In the PBDict, there are 3 val-2 verbs which do not have agent or patient. Their semantic roles are "container" and "content". Both of the roles can serve as the subject of the verb. The lack of the inner attitude holder "agent" makes a unique sentimental direction "speaker to content". The 3 verbs are "充斥(full of bad things)", "洋溢(full of good things)", "涌现(good things come forth)". Take "充斥" for instance, its content "假货(fakes)" is the subject and object in sentence(9a) and (10a). No matter what syntax role it takes, it is the one that the speaker negates.

充斥(full of bad things): <speaker, NEG, content>
(9a) 市场 **充斥** 着 假货。
(9b) The markets are **flooded** with fakes.
(9a') <speaker, NEG, "the fakes">
(10a) 假货 **充斥** 着 市场。
(10b) The fakes are **filling** the markets.
(10a') <speaker, NEG, "the fakes">

4.1.2.6 Semi-Val-2 Verbs.

Many intransitive verbs have one more semantic role other than agent. The role generally appears after a preposition and expresses the attitude of a holder. We name these verbs "semi-val-2 verbs", and call the preposition guided role as "dative". Thus, the inner holder "agent" may have its attitude towards the "dative". So these intransitive verbs may have the combined attitudes from the speaker and the agent. Take the verb "赞不绝口(speak highly)" as example, it carries the agent's positive attitude towards the dative in (11ab). As shown in (12ab), the verb "歌功颂德" carries 3 attitudes. It is like the standard val-2 verbs.

赞不绝口(speak highly):<agent, POS, dative>
(11a) 他 对 张 先生 **赞不绝口**。
(11b) He of Mr. Zhang **speaks highly**.
(11a') <"he", POS, "Mr. Zhang">

歌功颂德(sing merits and praise virtues –flatter):<speaker, NEG, agent>, <speaker,

NEG, dative>, <agent, POS, dative>

(12a) 一些 人 为 他 **歌功颂德**。

(12b) Some people for him **sing merits and praise virtues**.

(12a') <speaker, NEG, "some people">, <speaker, NEG, "him">, <"some people", POS, "him">

4.1.3 Val-3 Verbs.

4.1.3.1 Bitransitive Verbs.

The bitransitive verbs have three semantic roles, "agent", "dative" and "patient". Thus, the inner attitude maybe various, like "agent to patient", "agent to dative", "dative to patient". Theoretically, there could be more attitudes like "speaker to agent", "speaker to dative" and "speaker to patient" associated with the outer holder "speaker". However, the natural language sometimes makes things easier and purer. All the sentimental bitransitive verbs in the PBDict, as well as other verbs we can think of, only have one kind of sentimental direction "speaker to agent". (13ab) shows the attitude carried by word "敲诈 (extort)".

敲诈(extort):<speaker, NEG, agent>

(13a) 他们 **敲诈** 了 公司 500万。

(13b) They **extorted** (from) the company ￥5Million.

(13a') <speaker, NEG, "they">

4.1.3.2 Semi-Val-3 Verbs.

Quite similar to the semi-val-2 verbs in section 4.1.2.6, some val-1 and val-2 verbs have more semantic roles marked by propositions. These roles are highlighted by the propositions, and sometimes make the sentimental directions complex. Take the verb "强加" for instance. It's a val-2 verb which could have the "dative" guided by "给/于(to)".

强加(impose by force):<speaker, NEG, agent>, <speaker, POS, dative>, <dative, NEG, patient>

(14a) 20国集团 没有 法律权限, **强加** 政策 给 其他 国家

(14b) The G20 has no legitimacy to **impose** policies on other countries.

(14a') <speaker, NEG, The G20>, <speaker, POS, other countries>, <other countries, NEG, policies>

4.1.4. Statistical Results.

Table 1 shows the sentimental directions of verbs. Nearly all types of verbs have more than one kind of attitude rooted in the meaning of verbs, with 3 exceptions, val-1 verbs, container verbs and val-3 verbs.

TABLE 1. Sentimental Directions of Verbs

Verb Type	Basic Syntax Order	Holder	Object	POS/NEG	# of POS/NEG

Val-1	agent+v		speaker	agent	凯旋/得逞	45/80
Val-2	agent+v+patient	single	speaker	agent	挺进/把持	5/66
			speaker	agent+patient	牺牲/散布	1/10
			agent	patient	喜爱/伤害	37/3
		outer	speaker	agent/patient	投身/标榜	5/44
		inner	agent	patient		
Container Verb	container+v+content		speaker	content	洋溢/充斥	2/1
Semi-Val-2	agent+p+dative+v+patient	single	speaker	agent	谦让/撒谎	4/12
			speaker	agent+patient	*/狼狈为奸	0/1
			agent	patient/dative	赞不绝口/*	2/0
		outer	speaker	agent/dative	*/歌功颂德	0/5
		inner	agent	patient/dative		
Val-3	agent+v+dative+patient		speaker	agent	*/敲诈	0/6
Semi-Val-3	agent+p+dative+v+patient	single	speaker	agent	*/暗藏	0/1
			speaker	dative	费心/*	1/0
		outer	speaker	agent/dative	贡献/强加	2/1
		inner	agent/dative	dative/patient		

* means the words are not found in PBDict

4.2. Adjectives.

In Chinese, the adjectives can act as modifiers, predicates, adverbial modifiers and complements.

4.2.1 Modifier.

When used as modifiers, an adjective expresses the speaker's attitude to the nouns it modifies. Take the word "傲慢(arrogant)" for instance, it carries the negative attitude of the speaker to the head of a "adj+的+noun" phrase as shown in (15ab).

傲慢(arrogant):<speaker, NEG, head_noun>
(15a) 小强 是 一个 **傲慢** 的 孩子。
(15b) Xiaoqiang is an **arrogant** boy.
(15a') <speaker, NEG, "boy">

4.2.2 Adverbial Modifier.

When used as adverbial modifiers, an adjective expresses the speaker's attitude to the agent of the verb it modifies. In (16ab), when used as an adverbial modifier, "傲慢" means the speaker negates the agent "Xiaoqiang".

傲慢(arrogant):<speaker, NEG, agent_of_verb>
(16a) 小强 **傲慢** 地 批评 别人。
(16b) Xiaoqiang **arrogantly** criticizes others.
(16a') <speaker, NEG, "Xiaoqiang">

4.2.3 Complement.

When used as complement, an adjective expresses the speaker's attitude to the agent of the verb it completes, acting the same as being an adverbial modifier.

傲慢(arrogant):<speaker, NEG, agent_of_verb>
(17a) 小强 说话 很 **傲慢**。
(17b) Xiaoqiang speaks quite **arrogant**.
(17a') <speaker, NEG, "小强">

4.2.4 Predicate.

In Chinese, an adjective can act as a predicate without any copula. Like the intransitive verbs, it also expresses the speaker's attitude to the agent, see (18ab). Most adjectives are val-1 predicate. They have only one argument "agent".

优秀(excellent):<speaker, POS, agent>
(18a) 小强 很 **优秀**。
(18b) Xiaoqiang (is) very **excellent**.
(18a') <speaker, POS, "Xiaoqiang">

4.2.5 Semi-Val-2 Adjectives.

Like the semi-val-2 verbs, some adjectives are semi-val-2 predicates. They have another semantic role guided by a proposition like "对(to)". This will result in an inner attitude "agent to dative". These words also have the same sentimental directions of val-1 adjectives when used in the same manner.

(19a) 小强 对 别人 很 **傲慢**。
(19b) Xiaoqiang to others (is) very **arrogant**.
(19a') <speaker, NEG, Xiaoqiang>, <Xiaoqiang, NEG, others>

Table 2 gives the sentimental directions of adjectives. It shows that the val-1 adjectives have just 1 attitude in typical syntactic positions, while the semi-val-2 adjectives have more.

TABLE 2. Sentimental Directions of Adjectives and Adverbs

Type	**Basic Syntax Order**		**Holder**	**Object**	**POS/NEG**	**# of POS/NEG**
Val-1 Adj	adj(+的)+NP		speaker	NP	灿烂/冷酷	274/186
	agent+adj		speaker	agent	安详/呆板	
	agent+adj+VP agent+VP+adj		speaker	agent	流利/狂妄	
Semi-Val-2 Adj*	agent+p+dative+AP	single	agent	dative	坦白/冷冰冰	1/2
			speaker	agent	诚恳/夸夸其谈	15/9
		outer	speaker	agent	忠诚/凶残	4/8
		inner	agent	dative		
Adv	agent+adv+VP		speaker	agent	勇于/大肆	8/12

* the semi-val-2 adj also have the sentimental direction of val-1 adjectives.

4.3. Adverbs.

The sentiment adverbs express the speaker's attitude towards the agent of the verb modified by the adverb. It's like the sentimental directions of adjectives shown in section 4.2.2.

大肆(vigorously):<speaker, NEG, agent>

(20a) 默克尔 **大肆** 指责 中 俄 等 国家 的 人权 问题。

(20b) Merkel **vigorously** criticized human rights issues in countries such as China and Russia.

(20a') <speaker, NEG, "Merkel">

4.4. Nouns.

Nouns can be the subject and object of a verb. And the nouns can have more than 1 semantic role(see [13]), which result in a complex sentimental directions.

4.4.1. Reference of the Noun.

Sentimental noun shows the speaker's attitude towards the reference of the noun. For example, the noun "歹徒(gangster)" refers to those who commit crime or evil things. This kind of noun is called "val-0" noun, because it has no argument at all.

(21a) **歹徒** 破门而入。

(21b) The **gangsters** burst through the door.

(21a') <speaker, NEG, "**the men** burst through the door">

4.4.2 Assertions.

Sentiment nouns are often used as the predicative in assertions. It uses the subject as its argument. Thus, the reference of the subject noun is regarded as the object noun. And the noun carries the speaker's attitude towards the agent. We can see in (22ab), "歹徒(gangster)" refers to the subject "他们(they)".

歹徒(gangster):<speaker, NEG, subject>

(22a) 他们 是 一群 **歹徒**。

(22b) They are a group of **gangsters**.

(22a') <speaker, NEG, "they">

4.4.3 Possessives.

Many nouns are used as possessives in sentences. In Chinese, the linguistic marks of possessive are "有(have)" and "的(of)". (23ab), (24ab) demonstrate the attitudes from the speaker to possessive. Here, the agent of the verb "有(have)" can also be seen as possessive.

气魄(great spirit, grandeur):<speaker, POS, possessive>

(23a) 他 很 有 **气魄**。
(23b) He has **great spirits**.
(23a') <speaker, POS, "he">

气魄(great spirit, grandeur):<speaker, POS, possessive>
(24a) 我们 敬佩 他 的 **气魄**。
(24b) We admire his great spirits.
(24a'): <speaker, POS, "he">

4.4.4 Semi-Val-2 Nouns.

Some nouns have dative guided by proposition like "对(to, towards)". This will make combined attitudes. The noun "敌意(hostility)" means somebody bears a hostile attitude against others, and the speaker negates this hostility. So the inner attitude can be described as <agent, dative>, and outer attitude as <speaker, NEG, agent>. Then it has 2 intentional arguments, but it could not act as a verb controlling its subject and object. In (25ab), by being the object of the verb "有(have)", it realize its inner holder as the agent of "有", and by proposition phrase "对(towards)+她(her)", it has the inner attitude object "她(her)".

敌意(hostility):<speaker, NEG, agent>, <agent, dative>
(25a) 他 对 她 有 **敌意**。
(25b) He towards her has **hostility**.
(25a') <speaker, NEG, "he">, <"he", NEG, "she">

TABLE 3. Sentimental Directions of Nouns

Type	Basic Syntax Order	Holder	Object	POS/NEG	# of POS/NEG
Val-0	N+VP VP+N	speaker	reference of N	典范/暴徒	34/33
Val-1	possessive +有/的+N	speaker	possessive	风度/野心	23/20
	possessive+的+N	speaker	possessive	事迹/下场	10/16
Semi Val-2	agent+p+dative+有/的+N	agent	dative	热情/*	2/0
		speaker	agent	*/行径	0/2

* means the words are not found in PBDict

Table 3 listed the sentimental directions of nouns. They almost have a static attitude in a syntax structure.

5. Discussions from Linguistic and Computational Perspectives.

In section 4, we described the sentimental directions of words of 4 kinds: verbs, adjectives, adverbs and nouns. The directions are of varied types, which are interesting and require further linguistic theory to support our findings. In addition, how to apply the sentimental directions of words into real applications must be considered.

5.1 The Valence Determines the Types of Sentimental Directions.

If a word's valence is 1, there's only one attitude "speaker to agent". If the valences are

over 2, the attitudes vary from 1 to 4 in different words. The multi-attitudes expressed by a sentiment word are somewhat a challenge to the traditional linguistic theories.

5.2 Speaker versus Agent.

The outer holder “speaker” and the inner holder “agent” are the basic attitude holders in our framework for word sentiment description. There are two questions often put forward by researchers in and out of our team. The first one is “why speaker can play an important role?” The answer is of 2 aspects. First of all, when we want to find out the holder of the attitude in a phrase or sentence, we will see the hidden “speaker/writer”. And according to some linguists’ works, such as [14] and [15], the languages are not objective but subjective. However, if languages are subjective, we may wonder why the inner holder “agent” can have an attitude. The language we use is to express our thoughts and feelings. All the expressed content is the idea of speaker/writer. At the same time, we’ve already analyzed attitudes from the agent. The answer to this confusing problem could be like this: The agent’s attitude is what the speaker thinks the agent should have. In brief, all the attitudes belong to the speaker. The difference is, the speaker doesn’t judge the patient or dative directly, but the speaker believe the agent have an attitude towards the patient or dative. It is similar to the attitude corpus annotation schema introduced in [16].

The traditional terms like “good/bad word” or “praise/blame word” or “polarity word” or the sentiment orientation of a word have to be revised, because many sentiment words have 2 kinds of attitudes like “标榜(flaunt)”. We noticed that it is a “bad” word defined in the PBDict which can be found in the outer attitude trigrams <speaker, NEG, agent> and <speaker NEG, patient>, but it has a positive attitude from the agent to patient which is the inner attitude. So, the good/bad words are defined according to their outer attitude if a word has multiple attitudes in traditional dictionary. And if the speaker’s attitudes are different to the agent and patient like “诬蔑(slander)”, whose sentimental directions are <speaker, NEG, agent> and <speaker, POS, patient>, **it is the speaker’s attitude towards the agent which determines the “traditional polarity” of the word**. For the words only with the attitude from the agent to patient, like “表扬(praise)” and “批评(criticize)”, their “traditional polarity” is determined by the agent’s attitude.

Thus it can be summed that the sentiment structure of a word can be well described by the sentimental direction analysis, in which the speaker plays a dominating role for multi-attitude words.

5.3 Mono-syllable Word.

The sentiment words included in the PBDict are multi-syllable Chinese words. And there are still lots of mono-syllable sentiment words like “爱(love)” and “骗(cheat)”. These words can also be described using sentiment trigrams.

In ancient Chinese most words are mono-syllables, among them are some sentiment words, such as the famous three verbs “杀”, “弑” and “诛”. The three verbs are of the same basic meaning “杀(kill)”. But “弑” means to kill one’s king, father, elder brother etc., which is forbidden by ethic and law, while “诛” means to kill somebody by law. Thus, the attitudes expressed by “杀” is none, “弑” is <speaker, NEG, agent>, and “诛” are <speaker, POS, agent>, <speaker, NEG, patient>.

5.4 Is Sentimental Direction Universal?

We’ve shown that sentiment words in modern and ancient Chinese express different attitudes. But can this approach be applied to other languages like English or Japanese? The

sentiment meanings expressed by words are culture-dependent. They rely on the ethical system of judging to tell which is correct and which is wrong. If the system has more influence on language, it will form more sentiment words, and the sentimental directions will be stronger, especially the combinative attitudes of outer and inner holders. Thus the answer is straight forward now. No matter what language we are handling, it is necessary to use the sentiment trigram <holder, attitude, object> as a basic metric. And we've shown some English words like "praise", "arrogant" and "gangster" which can be analyzed this way.

Our work may be the answer to the question put forward by [17], "why words of different semantic orientation can make collocations in large corpus?" Traditionally, it is thought that positive words should co-occur with positive words, and negative words with negative words. Now, we know it is not necessarily the case. "诬蔑(slander)" is a negative verb, but the agent or patient of it do not need to be a negative noun. What is negated by the speaker is the agent. No matter what kind of word the agent is, it will be negated by the speaker.

5.5 Bottom-up Composition of Sentiments for Sentence and Document.

The aim of this article is to give a bottom-up composition of attitudes in sentences and documents. The sentiment words have been annotated with sentiment trigrams, matched on the results of semantic role labeling. We test sentence(20a) on the output of HIT dependency parser and semantic role tagger(http://ir.hit.edu.cn/demo/ltp/#). In their system, the agent is tagged as A0, and patient tagged as A1.

(20a) 默克尔 **大肆** 指责 中 俄 等 国家 的 人权 问题。

(20b) Merkel **vigorously** criticized countries such as China and Russia (for) human rights issues.

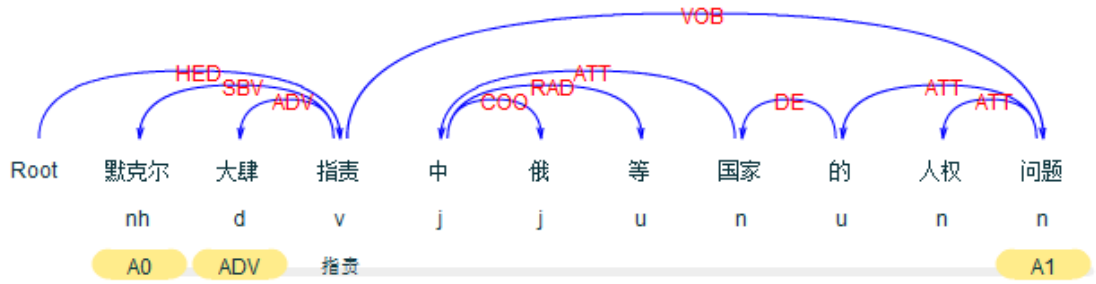

Figure 2: Output of HIT Dependency Parser.

So we can get the sentence's main semantic roles shown in (20cd). Having matched the sentimental directions of verb "指责"(20e) and the adverb "大肆"(20f), we got the attitudes of sentence shown in (20c').

(20c) [默克尔]$_{agent}$ [**大肆**]$_{adv}$ [指责]$_{v}$ [中 俄 等 国家 的 人权 问题]$_{patient}$。

(20d) [Merkel]$_{agent}$ [**vigorously**]$_{adv}$ [criticized]$_{v}$ [human rights issues in countries such as China and Russia]$_{patient}$.

(20e) 大肆(vigorously):<speaker, NEG, agent>

(20f) 指责(criticize):<speaker, NEG, agent>, <speaker, POS, patient>, <agent, POS, patient>

(20c') <speaker, NEG, "Merkel">, <speaker, POS, "human…Russia">, <"Merkel", NEG, "human…Russia">

On the basis of sentiment trigrams of sentences, we can use a bottom-up schema and composite the sentimental directions for the whole document. There could be hundreds of trigrams in a document, which are very informative for opinion extraction. We can easily get the frequency of the trigrams in one or more documents, then it will be clear what the main opinions of the speaker/writer, the people, and the organizer are in the data. Nevertheless, perfect results still call for the advances in semantic parser, anaphora resolution, etc. What can be done now is to apply our approach on parsed sentences to create a sentiment corpus for investigation and computation.

5.6 Is Trigram Enough?

The trigram we used for sentimental direction is <holder, attitude, object>. Are the 3 elements enough for more detailed analysis and applications? It is definitely not. We can add more elements or factors to the trigram, like subpart or feature of object, time of the attitude, location distribution of the holders, estate of the holders, as introduced by [2],[21]. Then we may compare people's attitudes on the same object in different parts of the world. The trigram is the basic frame for analysis. It has potentials to be extended to more complex multi-grams in applications.

6. **Automatic Construction of Sentiment Lexicon.**

We've shown the method to describe sentimental directions on 992 words. It requires heavy human labor and is very time-consuming. There're more sentiment words in Chinese and other languages. Can we find an algorithm to get these sentimental directions automatically? The answer is nearly yes, as we've found a semi-auto way. To get the sentiment trigrams, we need to know 3 elements, the holder, attitude and object. The whole procedure can be separated into 2 steps.

6.1 Polarity Acquisition.

The polarity(positive/negative) is not hard to get. [18] used constraints on the co-occurrence in conjunctions of words with similar or opposite polarity to predict the prior polarity of adjectives. On a corpus of 21 million words, 1336 adjectives are processed and the accuracy is about 78%. [19] introduced a method using "pointwise mutual information(PMI)" to get the semantic orientation(SO) of words, which employs co-occurrence of the word with positive and negative words to calculate the mutual information. If the word prefers to co-occur with positive words(in Table 4), its PMI value will be high, and vice versa. He tested the idea by querying the search engine AltaVista(www.altavista.com) to get the words' semantic orientations. On a lexicon of about 3600 English sentiment words, the accuracy is about 80%.

$$\mathrm{SO\_PMI}(word) = \log_2\left(\frac{\prod_{pword \in Pwords} hits(word \quad \mathrm{AND} \quad pword) \cdot \prod_{nword \in Nwords} hits(nword)}{\prod_{pword \in Pwords} hits(pword) \cdot \prod_{nword \in Nwords} hits(word \quad \mathrm{AND} \quad nword)}\right) \tag{1}$$

[20] tested Turney's SO_PMI method on Chinese words. They selected 20 polarity words as seeds in Table 4, and used the SO_PMI formula to test a lexicon of 249 words on

a corpus of 34M words. The precision and recall rate were 79.96% and 45.56%. When using 20 polarity morphemes in Table 4, the precision and recall rate increased to 80.23% and 85.03%.

TABLE 4. Polarity words used by Turney(2002) and Yuen(2004)

Language	Polarity	Morphemes and Words
English (words)	POS	good, nice, excellent, positive, fortunate, correct, superior
	NEG	bad, nasty, poor, negative, unfortunate, wrong, inferior
Chinese (words)	POS	诚实(honest),聪明(clever),充足(sufficient),幸运(lucky),正确(correct), 优秀(excellent),兴盛(prosperous),善良(kind),英勇(brave),谦虚(humble)
	NEG	虚伪(hypocritical),愚蠢(foolish),短缺(deficient),不幸(unlucky),错误(wrong), 恶劣(adverse),衰落(unsuccessful),残暴(violent),懦弱(cowardly),傲慢(arrogant)
Chinese (morphe-mes)	POS	奖(gift),胜(win),优(good),坚(secure),富(rich), 健(health),欢(happy),荣(honor),努(hardworking),顺(smooth)
	NEG	伤(hurt),贪(greedy),疑(doubt),困(difficult),急(rush), 妄(rash),爆(explode),禁(ban),倒(collapse),拒(reject)

[21] tested Turney's SO_PMI method on the polarity words from PBDict. Using the 20 seed words from Yuen(2004) and Baidu(www.baidu.com) as the search engine, the accuracy is about 81%.

As a whole, the automatic acquisition of polarity words is effective both on English and Chinese.

6.2 Tagging Holders and Objects.

We know that val-1 words have only one kind of sentimental direction "speaker to agent". If we can extract one word's valence, it will make things easier. There are at least 2 ways to get the valence. First, a great many dictionaries give the information about the type of the verbs: transitive, intransitive and bitransitive. This information is very helpful for specifying the valences of verbs. And there are dictionaries like "Semantic Knowledge-base of Contemporary Chinese" which give the word's valence. Second, we can extract the subcategories of English verbs automatically from large scale corpus as in [22]. [23] applied the method to extract the subcategories of Chinese verbs. Though the F-measure is not good(about 60%-70%), it is a complementarity to the dictionaries.

When the words' valence is over 2, we have to judge them by hand using principles given in section 3.2. As a whole, more than half of all works can be done automatically.

7. **Related Work.**

There have been some researches on sentiment lexicon constructions, but few noticed the multi-attitudes carried by sentimental words. On the other hand, some researches on building the sentiment corpus have made similar scheme for tagging sentences.

7.1 Sentimental Directions.

There're some researches on extracting opinion holders and analyzing opinions at the phrase level. [9] select the verbs correlated highly with opinion sentences, like "accuse", "doubt" and "think". They use the semantic roles given in FrameNet and PropBank to get

the opinion holder and the opinion proposition. They find that some holders of the attitudes are the speakers, some are agents and some are hidden in the sentence, but they did not model the multi-attitudes of a word. And most of the verbs they use are speech verbs like “think” and “say”, but not sentiment words.

As introduced in [16], the annotation scheme for MPQA(Multi-Perspective Question Answering) corpus are similar to ours. They annotated sentiment words or expressions as “text anchor”, holder of the opinion as “source”, object as “target”, and the polarity of attitude as “intensity”. The major difference between their approaches and ours is that they annotate these sentiment elements in corpus, but has not compiled a lexicon with semantic roles. It is possible to parse the sentences in MPQA corpus and extract a lexicon with sentimental directions. But according to Zipf’s law, many sentiment words will not appear in a corpus. So it is necessary to build a sentiment lexicon. And, they do not point out the relationship between the traditional polarity and the multiple attitudes of a sentiment word.

We know that the sentiments of verbs differ a lot from each other, so if the supervised learning algorithm meets a new sentiment verb in test data, it is very likely to fail. [24] applies the joint recognition of holders and objects from the MPQA corpus. [25] also use the FrameNet semantic role labeling as well as manual mappings from semantic to opinion roles to get the holder and object of the opinion. However, the results of their experiments are not very good. Thus, in [26] the founder of the MPQA argue that the recognition of holders and objects can hardly go beyond the capabilities of automatic semantic role labeling, and it is desirable to capture the nesting of the holders and to have generally available mappings between semantic roles and opinion roles for a large number of predicates. This is what we want to achieve for the construction of Chinese sentimental direction lexicon in this article.

In China, [27] use sentiment templates for Chinese speaking and judging verbs. Speaker, agent and patient are the basic elements in the templates. And a verb could have multiple templates which is similar to our approach. However, they do not give an explicit explanation or linguistic background of their method, and the sentiment words form only a small part in their lexicon. [28] introduce their construction of Chinese emotional corpus. For the attitudes, they tag the holder, attitude, key sentiment word/phrase and object in the sentences. But the sentences with attitudes again covers a small part of the corpus.

7.2 Sentiment Lexicons.

Table 5 shows some famous sentiment lexicons on the web, which have been widely used in sentiment computation. Usually, these words are given their part-of-speech and polarity. Compared with these lexicons, our lexicon size is smaller, but with semantic roles filled in their sentimental trigrams, and we intend to extend the lexicon with a semi-automatic approach in the future.

TABLE 5. Sentiment Lexicons

Lexicons	Language	Items POS/NEG	Download Page
General Inquirer	English	1915/2291	http://www.wjh.harvard.edu/~inquirer/

Lexicon			
OpinionFinder's Subjectivity Lexicon	English	2721/4913	http://www.cs.pitt.edu/mpqa/
Turney's Lexicon	English	2293/1914	http://www.webuse.umd.edu:9090/dictKS/
SentiWordNet	English	28431	http://sentiwordnet.isti.cnr.it/
NTUSD	Traditional/ Simplified Chinese	2812/8276	http://nlg18.csie.ntu.edu.tw:8080/opinion/
Polarity words from HowNet	Simplified Chinese	3013/3288	http://www.keenage.com/

8. **Conclusion and Future Work.**

In this article we propose a novel framework for sentiment word description. Using a trigram of <holder, attitude, object>, we distinguish 2 basic attitudes on 2 levels, the outer attitude from "speaker" towards the "agent/patient/dative", and the inner attitude from "agent" to "patient/dative". After manual annotation of 992 words, we found that the valence of a word determines by large the types of sentimental directions it carries. The words with only 1 semantic role have just the outer attitude<agent, attitude, object>, and the words with over 2 semantic roles may have attitudes on 2 levels. The 2 level-attitudes of words can be applied in getting the attitudes of phrase, sentence and discourse. Of course, the sentimental lexicon we built still need word sense disambiguation in real texts.

Our methodology looks like a rule-based one. And indeed it is, we want to give an explicit definition as the basis for resource construction and natural language modeling. As linguistic rules are hard and expensive to compile manually, we also design some automatic approaches for lexicon resources construction. We believe that the methodology used in the paper can be extended to the analysis of other emotions in languages.

In the future, we will analyze more sentiment words in Chinese and English. The two languages may differ in the sentimental directions for bilingual word-pairs, which would be useful in machine translation and second language teaching. We also plan to construct a sentiment corpus using the lexicon in order to model the sentiment computation more efficiently.

Acknowledgment. This paper is supported in part by National Social Science Fund of China under contract 10CYY021, 07BYY050, National Natural Science Fund of China under contract 60773173, and Nanjing Normal University Fund under contract 1009007. The authors also gratefully acknowledge the helpful comments and suggestions of the reviewers, and the annotation task done by the three post-graduates.

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